

PEDOMETER FOR DETECTING VIBRATIONS IN THE MOTION DIRECTION

3 BACKGROUND OF THE INVENTION

4 1. Field of the Invention

5 The present invention relates to a pedometer for detecting vibrations in
6 the stepping direction, in particular to a pedometer that can directly detect
7 vibrations of a jogger's body with a detector positioned orthogonal to the
8 moving direction.

9 2. Description of Related Arts

Pace counting devices can be classified into mechanical and electronic types. With reference to Fig. 7, the structure of a mechanical type pedometer includes a shell (50), a swing arm (51) being installed inside the shell (50) for normal operation in the upright position, a spring (52) and a weight (53) being attached to the end of the swing arm (51), an electronic switch (54) being disposed to correspond with the position of the weight (53); and a counting circuit (55) being connected to the electronic switch (54).

When in motion, the jogger's feet pound the ground exerting a downward force. Since the swing arm (51) is positioned perpendicular to the horizontal plane, the downward force will pull down the weight (53) to touch the electronic switch (54), thus the electronic switch (54) is toggled by the footsteps. The counting circuit (55) thereafter detects the status change in the electronic switch (54), and then increases the count by one. Therefore, the pace count will continue until when the jogger stops moving. The counting circuit (55) working in conjunction with the electronic switch (54) and the swing arm

1 (51) records the actual footsteps of the jogger. However, this kind of
2 mechanical pedometer is known to have weaknesses, such as too much noise
3 disturbance, oxidation of the contact points, and metal exhaustion of the spring.
4 In addition, since the device is inherently designed for upright mounting, only
5 directly downward vibrations can toggle the electronic switch (54) in the
6 counter to produce the pace count, whereby false readings may occur if the
7 vibration is oblique to the switch. Such false readings will be very confusing
8 and probably infuriating to the jogger as obviously such a person has a
9 particular interest in knowing the precise distance traveled.

10 In order to overcome the weaknesses mentioned above, electronic
11 pedometers having higher precision have recently been developed. The
12 physical structure of a typical electronic type pedometer is illustrated in Fig. 8,
13 including a shell (60), a ceramic piezoelectric component (61) being installed
14 laterally inside the shell (60), and a counting circuit (62) being connected to the
15 ceramic piezoelectric component (61).

16 The above ceramic piezoelectric component (61) detects substantial
17 downward force generated by walking, jogging etc, and converts the downward
18 force into a signal output to the counting circuit (62) for pace counting.

19 The use of the ceramic piezoelectric component (61) to detect
20 downward vibration can eliminate the problems associated with the swing arm
21 (51) in a mechanical pedometer. Since the ceramic piezoelectric component (61)
22 is designed to detect downward force exerted by motion, the counting circuit
23 (62) has to be mounted laterally inside the counter shell (50) which is secured
24 onto the jogger in order to take the pace count with accuracy.

1 Some manufacturers have tried to increase the length of ceramic
2 piezoelectric component (61) to increase the efficiency of the pedometer, while
3 keeping the slim shape of a portable pedometer. Others have tried to increase
4 the payload to increase the sensitivity of the pedometer, but this kind of
5 modification also magnifies after shocks following each foot step, which often
6 causes the counting circuit to pick up after shock signals resulting in counting
7 errors.

8 From the above discussion of these two types of pedometers, it is
9 apparent that the conventional vibration detector has to rely on more substantial
10 downward force generated by footsteps to maintain an accurate counting.
11 Furthermore, the jogger has to preset the direction parameter of the counting
12 device telling the counting device which direction the jogger is going to take;
13 otherwise, some of the counting devices may record incorrect pace counts. To
14 correct this problem, some manufacturers of pedometers have come up with
15 new pedometers claiming that the new counters do not need presetting of the
16 stepping direction, and the size of these counters is small enough to be carried
17 along in a pocket. However, in reality, if the stepping direction is not preset, the
18 pace counting by these portable devices is not very reliable.

19 To satisfy the need for a direction-less pedometer, the pedometer has to
20 use two vibration detectors orthogonally disposed to each other to detect
21 vibrations from every direction, such that the counter can be rotated angles
22 without affecting the operation results. Looking at the current market situation,
23 pedometers with such capabilities usually have a large physical size and are
24 relatively expensive.

1 SUMMARY OF THE INVENTION

2 The main object of the present invention is to provide a pedometer that
3 can detect body vibrations in the motion direction, and can still be operated
4 accurately after changing the counter position.

5 Such a pedometer is fully portable and uses a single detector for
6 detecting body vibration. Other advantages of the new pedometer are that it can
7 directly detect body vibrations in the direction of motion, and the new counter
8 is less affected by after shocks as compared with conventional pedometers.
9 Using a piezoelectric element, the new pedometer is able to directly detect
10 body vibrations in the motion direction with good accuracy.

11 To this end, the physical structure of the pedometer comprises:

12 a main body;
13 a vibration detector being laterally installed inside the main body; and
14 a counting circuit also being laterally installed inside the main body,
15 which is formed by a signal amplifier circuit and a signal detection circuit.

16 The present invention is characterized in that the pedometer having an
17 orthogonal vibration detector is able to detect body vibrations generated by a
18 jogger in the direction of motion. Furthermore, the new pedometer has a signal
19 amplifier circuit built in for amplifying weak vibration signals in a certain
20 direction if the vibration detector is moved to a different position other than the
21 orthogonal position.

22 The present invention is also characterized in that a single vibration
23 detector is used in the pedometer. With proper positioning of the vibration
24 detector orthogonal to the direction of motion and the sophisticated control

1 logic in the counting circuit, the new pedometer is able to take accurate count
2 of the jogger's pace without having to use two orthogonal vibration counters.

3 The features and structure of the present invention will be more clearly
4 understood when taken in conjunction with the accompanying drawings.

5 **BRIEF DESCRIPTION OF THE DRAWINGS**

6 Fig. 1 is an exploded diagram of the architecture of the pedometer in
7 accordance with the present invention;

8 Fig. 2 is a block diagram of the control circuitry in the new pedometer;

9 Fig. 3 is a partial schematic diagram of the control circuitry;

10 Fig. 4 is a conceptual diagram of the mounting of the pedometer on the
11 waistband of a jogger;

12 Fig. 5 is a perspective diagram of the pedometer;

13 Fig. 6A, 6B are waveform diagrams of the output vibration signals;

14 Fig. 7 is a structural diagram of the mechanical pedometer; and

15 Fig. 8 is a structural diagram of an electronic pedometer.

16 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

17 The present invention provides a pedometer for detecting vibrations in
18 the direction of motion, which is able to detect body vibrations in the direction
19 of motion. In Fig. 1, the basic structure of the new pedometer comprises a main
20 body (10), a printed circuit board (20), and a counting circuit (30) (not shown
21 in the diagram). The main body (10) consists of a shell base (100) and an outer
22 shell (101), wherein the back end of the shell base (100) has a clip (102)
23 attached thereto for securing the pedometer on the jogger's body.

24 The printed circuit board (20) is installed laterally over the shell base

1 (100) and has a counting circuit (30) (not shown in the diagram) embedded
2 therein. A vibration detector (11) is fixed on the printed circuit board (20) and
3 connected to the counting circuit (30), and a sensing pad (110) linking to the
4 vibration detector (11) is placed perpendicular to the horizontal plane for
5 sensing the motion vibrations in the motion direction A as shown in Fig. 5. In
6 other words, a direction that the vibration detector (11) possesses the best
7 sensitivity is the same as a moving direction of the jogger.

8 The vibration detector (11) is formed as a circular or rectangular
9 ceramic piezoelectric element. Referring to Figs 1, 2, 3, and 5, a display unit (12)
10 is installed on the printed circuit board (20) and connected to the counting
11 circuit (30) for displaying a pace count value. An optional key pad (13) is
12 placed on the printed circuit board (20) and connected to the counting circuit
13 (30).

14 The counting circuit (30), as shown in Fig. 2, includes a signal
15 amplifier (31), a signal detection circuit (32), and a processor (33).

16 The signal amplifier (31) is connected to the output of the vibration
17 detector (11). The vibration detection signals are passed through a filter (311)
18 and a signal amplifier (312), wherein the input of the filter (311) is connected
19 to the vibration detector (11), whilst the output is connected to the input of the
20 signal amplifier (312).

21 A signal detection circuit (32) is connected to the output of signal
22 amplifier (31) for sensing vibration signals output by the signal amplifier (31).
23 The signal detection circuit (32) is formed by a low-pass filter (321), a voltage
24 divider (322) and a comparator (323), wherein the voltage divider (322) is

1 formed by two series connected resistors (R1, R2), and a grounded capacitor
2 (C1), such that the low-pass filter (321) and the voltage divider (322) are both
3 connected to the positive input E of the comparator (323).

4 The input of the processor (33) is connected to the output D of the
5 comparator (323) in the signal detection circuit (32), whilst the output is
6 connected to the negative input F (reference voltage terminal) of the
7 comparator (323), and the processor (33) is connected to the display unit (12)
8 and the optional key pad (13).

9 The structure and the design of the new pedometer have been described
10 above. The method of operating the new pedometer is explained below.

11 With reference to Figs. 4 and 5, the clip (102) (not shown in the
12 diagram) is attached to the back of the shell base (100). The clip (102) allows
13 the pedometer to be securely attached onto the waistband of the jogger, such
14 that the sensing pad (110) of the vibration detector (11) is disposed orthogonal
15 to the motion direction of the jogger. When the jogger starts to walk or run, the
16 vibration detector (11) is able to detect the smallest amount of body vibration in
17 the motion direction A and then outputs a vibration detection signal to the
18 counting circuit (30) for cumulative counting.

19 The circuit actions of the counting circuit (30) are explained in
20 reference to Figs. 2 and 3. When the vibration detector (11) outputs a weak
21 vibration detection signal to the signal amplifier circuit (31) due to the
22 positioning of the counter, the signal is first passed through the filter (311) for
23 filtering out any high frequency noise, and then the signal is fed through the
24 signal amplifier (312) for signal amplification. The amplified signal is then

1 output to the signal detection circuit (32), wherein the signal first passes
2 through a low-pass filter (321) to the positive input E of the comparator (323).
3 At the same time, the amplified signal is branched through the voltage divider
4 (322) to the negative input F (reference voltage) of the comparator (323).

5 When the vibration detector (11) does not output vibration detection
6 signals, the signal amplifier (312) outputs a signal with positive potential to the
7 signal detection circuit (32). Since the signal input to the negative input F
8 (reference voltage) is fed through the voltage divider (322), the resultant
9 voltage is less than the voltage on the positive input E, thus the comparator
10 outputs a signal with positive potential.

11 With reference to Fig. 6A, the amplified vibration detection signal from
12 the vibration detector (11) to the signal detection circuit (32) charges the
13 capacitor C1 in the voltage divider (322), which causes the rate of voltage
14 increase on the negative input F (reference voltage) of the comparator (323) to
15 be slower than that on the positive input E. Therefore, when a surge signal with
16 negative potential appears on the vibration detection signal line, the voltage on
17 the positive input E is higher than that on the negative input F (reference
18 voltage) due to the delay effect of the capacitor C1. Therefore, the comparator
19 (323) outputs a signal with negative potential from output D to the processor
20 (33) once a surge signal appears, indicating that the vibration detection signal
21 has successfully detected the surge signal. Since the amplified vibration
22 detection signal may carry after signals, which may cause false output by the
23 comparator (323), the vibration signal has to pass through a filter.

24 With reference to Fig. 6B, when the processor (33) receives the surge

1 signal from the comparator (323), the processor (33) outputs a pulse signal to
2 the negative input F (reference voltage) to cause the previously charged
3 capacitor C1 to discharge. Since the amplitude of after signals is usually small,
4 the signal output of the processor (33) can be appropriately tuned to carry an
5 amplitude slightly greater than after signals, such that the comparator (323) will
6 not react to after signals.

7 Using the preferred embodiment for the illustration, when the
8 pedometer is set to the rate of four steps in every second, then the pulse width
9 of the output signal from the processor (33) is 250 ms. Through the capacitor
10 C1, the voltage on the reference voltage terminal increases smoothly. Since the
11 sensitivity level is set, any vibration with a rate greater than the preset level can
12 not be real and thus is disregarded. Using the control input C to the reference
13 voltage terminal, the sensitivity level of the comparator (323) can be tuned to
14 the desired level for removing after signals.

15 In summary, the present invention has several advantages over the
16 conventional pedometers in that a single vibration detector is used to detect the
17 smallest body vibration in the stepping direction and filter out unwanted after
18 signals even if the pedometer is not disposed in a position not perfectly along to
19 the belt.

20 The foregoing description of the preferred embodiments of the present
21 invention is intended to be illustrative only and, under no circumstances,
22 should the scope of the present invention be so restricted.